

II.13 What, When, and Where Do Grasshoppers Eat?

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Some species of grasshoppers do not readily take baits. As a result, the effectiveness of grasshopper control through bait applications can be limited. Various researchers have attempted to increase bait effectiveness. These studies have focused primarily on comparing toxicants, varying applications timing, and varying the amount of toxicant on the bait applied. Carefully designed and executed experiments with alternate insecticides and time-of-day application did not lead to increases in grasshopper mortality among the species that did not feed on bait in other experiments. The Grasshopper Integrated Pest Management (GHIPM) Project conducted observation studies to improve baits through better understanding of grasshopper feeding behavior.

Findings of Direct Observations

During the summers of 1990 and 1991, GHIPM Project experiments involved direct observation of grasshoppers feeding on host plants in rangelands. The study focused on species that readily take bait and species that do not. The study sites were typical prairies in western South Dakota and North Dakota. The grasshopper densities were representative of those targeted for bait control programs (greater than 10 but less than 25 grasshoppers/m²). Observation involved watching individual grasshoppers from daybreak to dusk and recording their behavior every 15 seconds.

Most of the behavior observed had very little to do with feeding. Grasshoppers basked in the sun, moved about their habitat, and exhibited avoidance behavior. Most observations were of third-instar (young grasshoppers) to adults.

The study included four common species that are not easily controlled by bait applications at the standard rate of 1.5 lb/acre containing 2 percent carbaryl. These species were *Amphitornus coloradus* (Thomas), *Cordillacris occipitalis* (Thomas), *Trachyrhachys kiowa* Thomas, and *Phlibostroma quadrimaculatum* (Thomas). Also, the study compared these four species' behavior with that of two species that are easily controlled with baits—*Aulocara elliotti* (Thomas) and *Ageneotettix deorum* (Scudder).

Usually grasshoppers spent the early morning basking. After the air temperature reached 81 °F, the grasshoppers began to feed. Grasshoppers allowed time for their crops to empty between feeding sessions and repeated feeding and resting cycles regularly. The insects generally groomed their antennae and eyes before feeding, but grooming apparently was not a prerequisite to feeding.

Feeding continued throughout the day if temperatures remained below 90 °F. When temperatures rose above 95 °F, the grasshoppers perched on stems or took shelter under vegetation to avoid excessive heat. While the temperature remained elevated, the grasshoppers did not actively feed; active feeding resumed when the temperature fell. In other experiments designed to determine the optimal time of bait application (including experiments during the GHIPM Project), temperatures remained below 90 °F so that timing of application was not a significant factor for most of the grasshopper population.

Very little feeding took place when winds exceeded 15 miles per hour (mi/hour) or during cool, cloudy days. The insects would remain quiet until weather conditions improved. Grasshoppers also stopped feeding when rain was imminent. After showers or rains passed and the ground warmed, grasshoppers returned to feeding.

Although grasshoppers spent one-seventh of their time moving, the movement appeared to be random. Most of the time, grasshoppers were on the soil surface and climbed the plants only to feed. The exception was *Amphitornus coloradus*. This species would enter a clump of grass and position itself so its body was nearly vertical. The upright position, combined with its cryptic body markings, gave the grasshopper maximum protection from predators. For this species, feeding behavior seemed to be balanced carefully between the need to feed and to remain hidden.

Grasshoppers were very discriminating in their food choices. They would sample a blade of grass before feeding on it and occasionally move back to a portion of the blade or another blade passed over previously. *T. kiowa*, one that does accept bran bait, often would feed on a plant, move a short distance, and then return to the same plant and resume feeding. The activity showed the

grasshopper was capable of relocating a suitable host plant. Grasshoppers fed on the tips of leaf blades or would clip the tip of a blade and then feed on the tip while grasping it with their forelegs. When the latter feeding habit occurred, the grasshoppers usually ate all of the clipped portion. The other common feeding pattern was to bite a portion out of a leaf margin, leaving it notched.

Aulocara elliotti and *Ageneotettix deorum*, the two species that readily eat bran bait, often picked up bits of plant litter from the soil surface and tasted and consumed those food items in addition to feeding actively on live tissue. These two species also clipped the leaf tips but dropped the clippings to the ground and later fed on the sun-dried clippings. The four species that do not accept bran bait seldom fed on materials found on the soil surface and preferred live tissue.

Additional tests showed species that feed on live tissue and do not take baits would accept baits glued to host plants. *Cordillacris occipitalis* and *Aulocara elliotti* were caged on a host plant that is acceptable to both species. Bait particles were glued to the host at the leaf tip, midleaf, and at the leaf base. Grasshoppers were allowed to browse for 8 hours. Grasshoppers caged on untreated leaves had no mortality, while both species caged on treated leaves showed equal mortality.

Conclusions

Grasshoppers in this study spent only a small portion of their time feeding. They fed in sessions interspersed with rest or movement (see table II.13–1.) Grasshopper species that were easily controlled with baits fed on plant litter and detrital material on the ground and were therefore predisposed to feed on bran baits. Grasshoppers that did not take baits fed on living host plants.

One approach to enhancing bait effectiveness would be to treat the bait with a sticking agent as the bait is applied. Some of the treated bait would then be encountered by grasshoppers feeding on live host plants. Bait falling on the soil surface will remain available to ground-feeding species.

Attracting grasshoppers that feed on live tissue to bait and positioning bait in the known feeding locations are some areas for the next stage of research.

Table II.13–1—Summary of feeding behaviors for six species of grasshoppers

Species	Percent of time engaged in:			Total hours
	Basking	Moving	Feeding	
<i>Ageneotettix deorum</i>	81.8	13.9	4.4	14.9
<i>Aulocara elliotti</i>	69.5	17.2	13.2	25.5
<i>Amphitornus coloradus</i>	77.4	8.4	14.2	57.8
<i>Cordillacris occipitalis</i>	81.0	9.1	9.8	18.8
<i>Phlibostroma quadrimaculatum</i>	76.8	18.4	5.8	14.4
<i>Trachyrhachys kiowa</i>	36.8	31.4	31.7	14.9